

Bachman, Tom A.

From: John Graves [jgraves@minnkota.com]
Sent: Wednesday, March 24, 2010 8:34 AM
To: Bachman, Tom A.
Subject: Use of Confidential Information

Tom,

Haldour Topsoe has agreed to the use of their information as you previously described.

John T. Graves, P.E.
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3.3 Catalyst Specification, Exceptions & Offer

Based on the current data available, including the Microbeam Technologies report dated August 20, 2009, HTI believes that the low dust (after ESP) option is the most viable. HTI feels that deactivation of the catalyst due to alkali poisoning (sodium) will be the biggest challenge. However, with that said, HTI also recognizes that chemical deactivation can generally be managed with the adjustment of catalyst volume and/or guarantee life while the potential exists that physical deactivation due to catalyst blinding and plugging could be severe enough to make SCR a non-viable option for controlling NO_x emissions.

The absence of SO₂ downstream of the FGD has been discussed and the effect it might have on physical deactivation of the catalyst due to blinding. Considering that most of the calcium will be removed in the ESP, calcium sulfate formation should be minimal. Also, considering the low operating temperature of the SCR (~600F) chemical poisoning of the catalyst affects the observed activity much more than does physical poisoning (blinding) of the catalyst. The tail-end option should be considered further with actual slip stream or mini reactor testing on an operating unit but at this time HTI feels that with the data currently available that the low dust option is the best option available.

HTI's main concern in relation to the lignite fuel is the content of alkali metals (sodium in the case of ND lignite) which leads to chemical poisoning of the catalyst by reacting with the vanadium active sites. The deactivating effect of sodium (and potassium) will be the same, whether in the form of oxide, sulfate or another salt. The deposition rate of the aerosols could be different, though, depending on whether they are in the form of oxides or sulfates due to differences in mobility.

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From: John Graves [jgraves@minnkota.com]
Sent: Wednesday, March 17, 2010 9:22 AM
To: Bachman, Tom A.
Subject: Minnkota BACT - Use of Confidential information

Tom,,

CERAM will allow the use of several paragraphs from their October 13, 2009 proposal in your analysis of our recent BACT submittals. Specifically they will allow the use of the material on Page 3, paragraphs 2, 3 and 5(which continues on page 4) beginning with "The high levels....." and ending with " ...calcium oxide present in the flue gas."

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CERAM Environmental, Inc.
Porzellanfabrik Frauenthal GmbH

Minnkota Power Cooperative
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CONFIDENTIAL

In accordance with Air Pollution Control Rules
for the State of North Dakota at 33-15-01-16

October 13, 2009

Boiler Type and Fuel Analysis

The levels of K_2O in the ND lignite ash are in the high end range found in many biomass fuels, such as wood and switch grass. However, the levels of Na_2O are much greater than that found in biomass or coal fired SCR applications. Different boiler types will affect deactivation. CERAM's experience with biomass applications that utilize a bubbling fluidized bed (BFB) boiler with the SCR in a high dust arrangement have been successful because we were able to size the catalyst appropriately and take advantage of the lower flame temperature (e.g., less oxidized poisons), available sorbent (e.g., limestone) that can absorb a portion of the catalyst poisons and the fact that a large portion of the ash is entrained. Pulverized coal (PC), stoker and cyclone boilers in the high dust arrangement can lead to an increase in deactivation due to the higher local flame temperatures and areas of incomplete combustion that both can lead to a severe increase in oxidized poisons. Solutions to reduce catalyst deactivation have been to use low dust (e.g., catalyst downstream of a baghouse with sorbent injection) and tail end (e.g., downstream baghouse and scrubber) configurations. However, our experience on low dust and tail end biomass and incinerator applications with similar fuel characteristics have shown that increased deactivation will still occur compared to similar applications firing sub-bituminous and bituminous coals.

The high levels of Na_2O in the ash for the ND lignite are not commonly found in sub-bituminous and bituminous coals which are fired with SCR systems. CERAM is unaware of any SCR application experience in the industry with this level and form of sodium in the ash. Sodium is a well known catalyst poison. In particulate form the effects of sodium can be controlled by maintaining warm and dry conditions on the catalyst at all times during layup. Allowing moist conditions on the catalyst will result in the particulate bound sodium leaching into the pore structure of the catalyst where catalyst poisoning will occur. Small aerosol particles can penetrate and neutralize active catalyst sites even in dry conditions.

Catalyst Deactivation

For this application we can assume that most of the ash will be removed; however catalyst deactivation will still occur due to gaseous constituents in the flue gas and from the small amount of ash that will reach the reactor. Even though this application may be either a low dust or tail end application it is not a "no dust" application. Deactivation can be caused by exposure to various catalyst poisons and fouling agents, such as alkaline metals, arsenic, sulfate compounds,

silica and phosphorous compounds, hydrochloric and hydrofluoric acids, sodium and potassium in the ash, etc., that are formed during the combustion process. Catalyst installed in even low dust and tail end locations are poisoned from the exposure to the flue gas. Some of the potential catalyst poisons that could lead to deactivation of our catalyst are found in the mineral and trace analysis or can be controlled by temperature. The amount of sulfur dioxide, sulfur trioxide and sulfuric acid are a function of temperature, thereby if the temperature is controlled above the acid dew point then no problems should exist. In addition, the amount of lead, mercury, chromium and other metals listed in the trace analysis are typically extremely low and should not be a major influencing factor for a coal fired application. Moreover, the high levels of phosphorous, sodium and potassium found in the mineral analysis will increase deactivation rates. Arsenic poisoning will occur, however the levels for which this can be attributed to are a function of the amount of calcium oxide present in the flue gas.